

FIG. 1

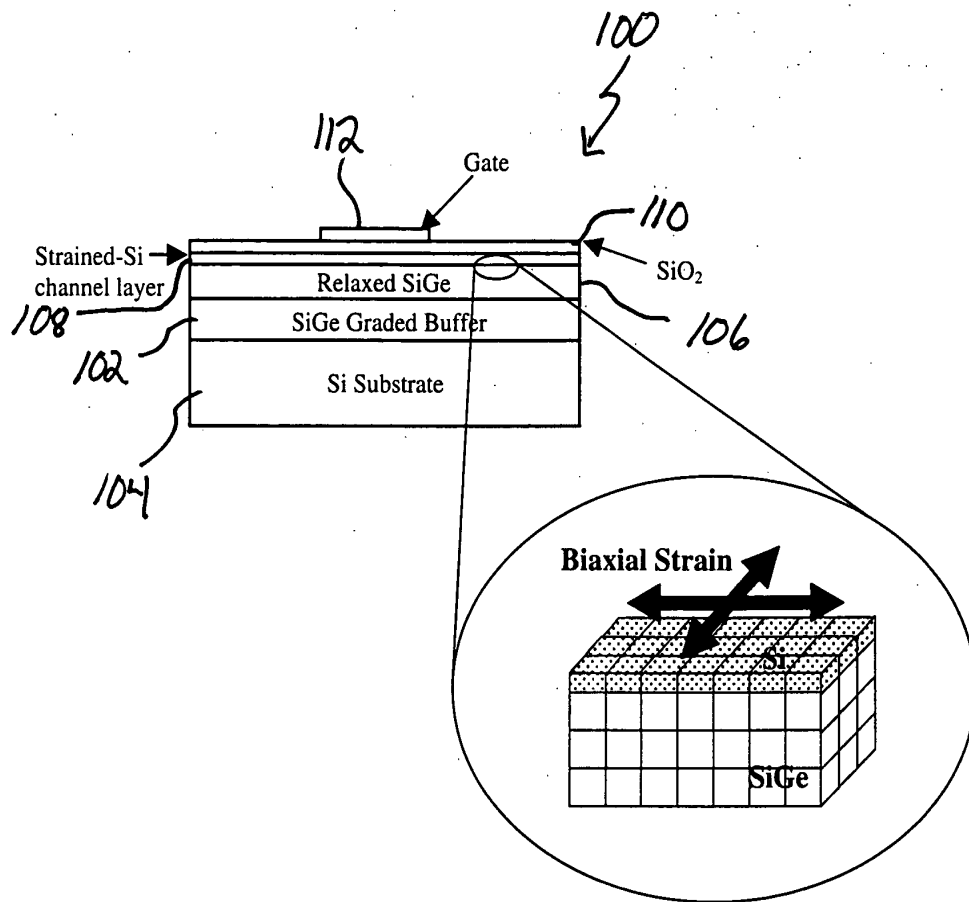


Fig. 1

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Fig. 2A

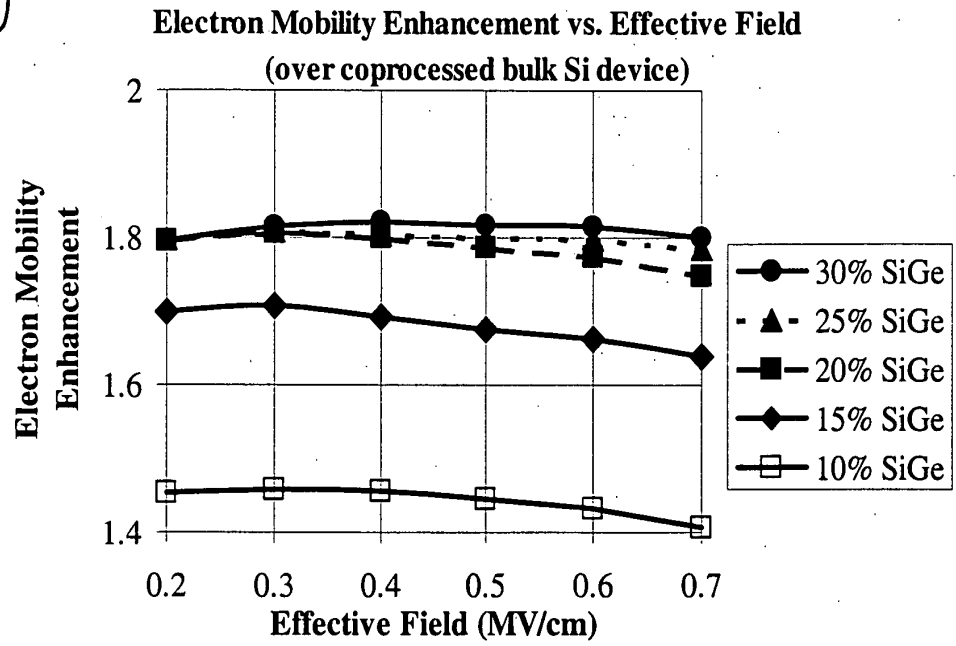
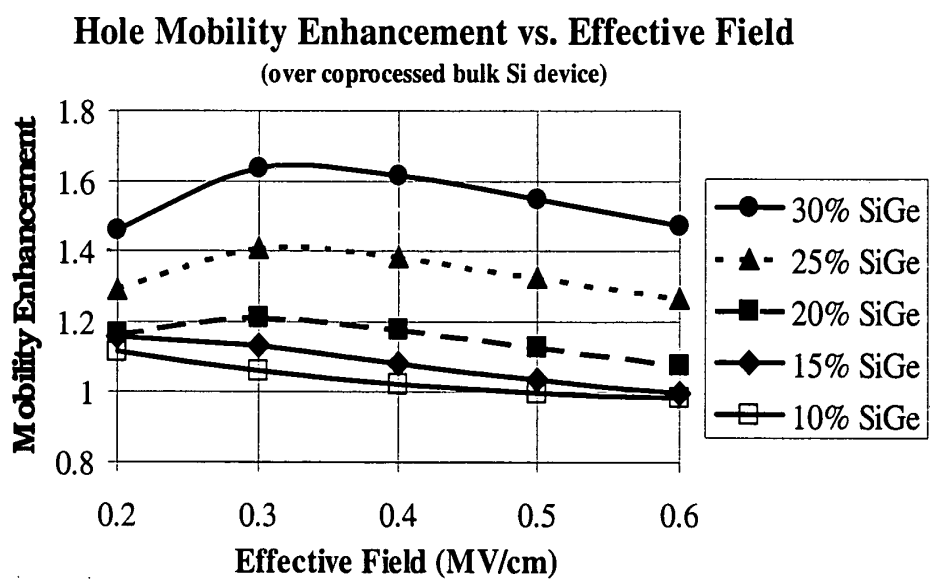


Fig. 2B



| Type of Surface                          | Average Roughness<br>(nm) |
|--|---------------------------|
| As-grown graded composition relaxed SiGe | 7.9                       |
| Planarized SiGe                          | 0.57                      |
| Regrowth SiGe                            | ~0.6                      |

Fig. 3

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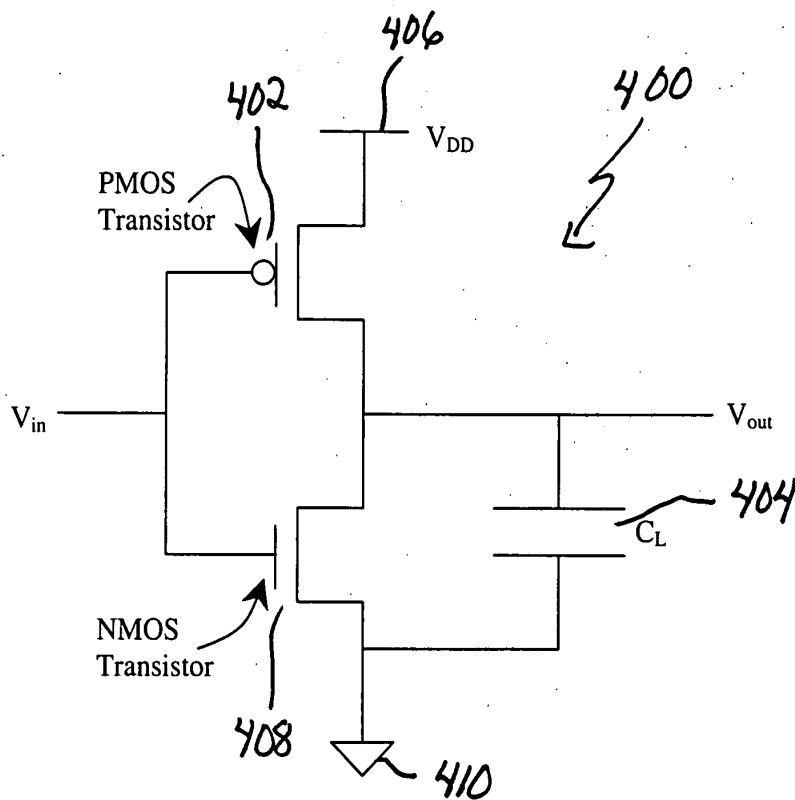
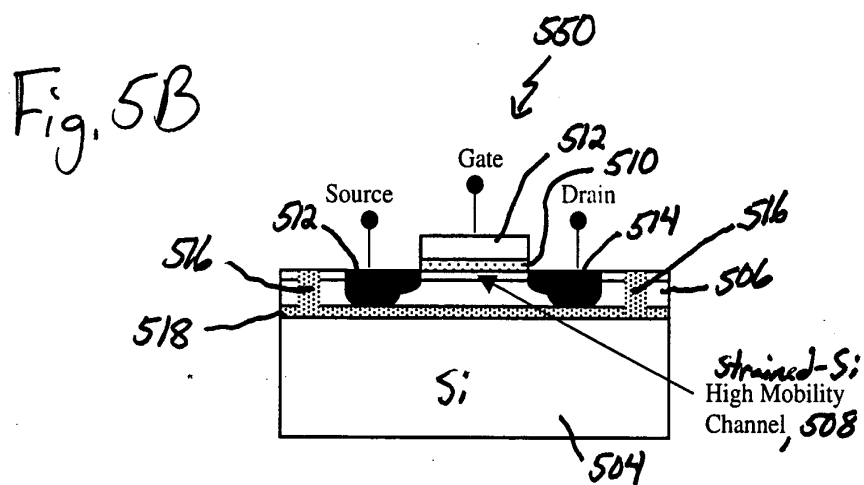
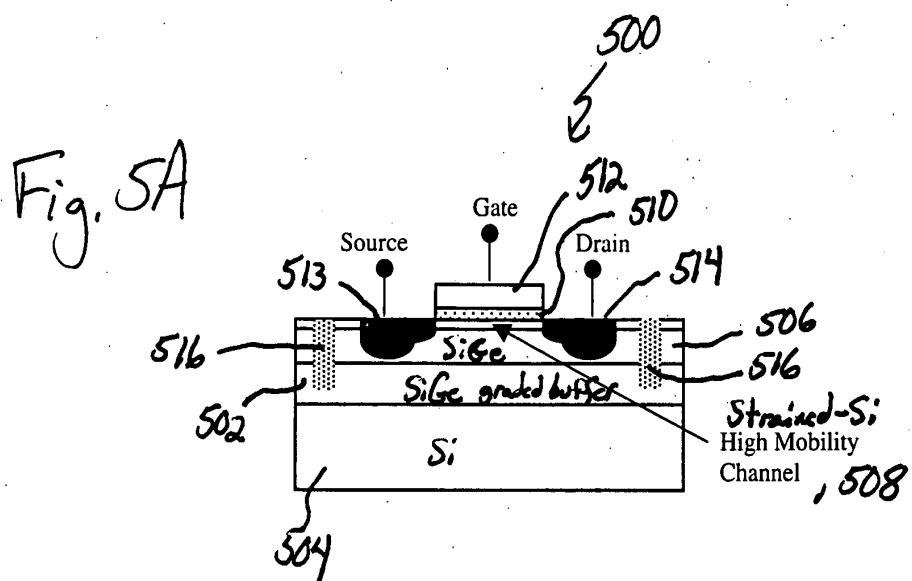


Fig. 4



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|                                  | n enhancement | p enhancement |
|----------------------------------|---------------|---------------|
| $\text{Si}_{0.8}\text{Ge}_{0.2}$ | 1.75          | 1             |
| $\text{Si}_{0.7}\text{Ge}_{0.3}$ | 1.8           | 1.4           |

Fig. 6

|                              | Bulk Silicon | Strained-Si on 20% SiGe: High Speed | Strained-Si on 30% SiGe: High Speed | Strained-Si on 20% SiGe: Low Power | Strained-Si on 30% SiGe: Low Power |
|------------------------------|--------------|-------------------------------------|-------------------------------------|------------------------------------|------------------------------------|
| n enhancement                | 1            | 1.75                                | 1.8                                 | 1.75                               | 1.8                                |
| p enhancement                | 1            | 1                                   | 1.4                                 | 1                                  | 1.4                                |
| $W_p$ ( $\mu\text{m}$ )      | 5.4          | 5.4                                 | 5.4                                 | 5.4                                | 5.4                                |
| $W_n$ ( $\mu\text{m}$ )      | 1.8          | 1.8                                 | 1.8                                 | 1.8                                | 1.8                                |
| $L_n, L_p$ ( $\mu\text{m}$ ) | 1.2          | 1.2                                 | 1.2                                 | 1.2                                | 1.2                                |
| $C_L$ (fF)                   | 32           | 32                                  | 32                                  | 32                                 | 32                                 |
| $V_{DD}$ (V)                 | 5            | 4.7                                 | 4.4                                 | 4.3                                | 3.8                                |
| $NM_H$ (V)                   | 2.053        | 2.218                               | 1.949                               | 2.037                              | 1.682                              |
| $NM_L$ (V)                   | 2.067        | 1.654                               | 1.721                               | 1.542                              | 1.504                              |
| $t_{pHL}$ (psec)             | 211.3        | 133.7                               | 141.6                               | 152.2                              | 180.1                              |
| $t_{pLH}$ (psec)             | 195.8        | 220.0                               | 173.3                               | 254.8                              | 226.9                              |
| $t_p$ (psec)                 | 203.5        | 176.9                               | 157.4                               | 203.5                              | 203.5                              |
| Power (mW)                   | 3.93         | 3.93                                | 3.93                                | 2.87                               | 2.21                               |
| <b>% Speed Increase</b>      | -            | <b>15.1%</b>                        | <b>29.3%</b>                        | -                                  | -                                  |
| <b>% Power Reduction</b>     | -            | -                                   | -                                   | <b>27.0%</b>                       | <b>43.7%</b>                       |

Fig. 7

|                        | Bulk Silicon | Strained-Si on 20% SiGe: Constant $V_{DD}$ | Strained-Si on 30% SiGe: Constant $V_{DD}$ | Strained-Si on 20% SiGe: High Speed Symmetrical Inverter | Strained-Si on 30% SiGe: High Speed Symmetrical Inverter | Strained-Si on 20% SiGe: Low Power Symmetrical Inverter | Strained-Si on 30% SiGe: Low Power Symmetrical Inverter |
|------------------------|--------------|--|--|--|--|---|---|
| n enhancement          | 1            | 1.75                                       | 1.8  | 1.75   | 1.8  | 1.75  | 1.8   |
| p enhancement          | 1            | 1  | 1.4  | 1  | 1.4  | 1   | 1.4   |
| $W_p$ ( $\mu m$ )      | 5.4          | 5.4  | 5.4  | 9.45   | 6.94   | 9.45  | 6.94  |
| $W_n$ ( $\mu m$ )      | 1.8          | 1.8  | 1.8  | 1.8  | 1.8  | 1.8   | 1.8   |
| $L_n, L_p$ ( $\mu m$ ) | 1.2          | 1.2  | 1.2  | 1.2  | 1.2  | 1.2   | 1.2   |
| $C_L$ (fF)             | 32           | 32   | 32   | 32   | 32   | 32  | 32  |
| $V_{DD}$ (V)           | 5            | 5  | 5  | 4.3  | 4.2  | 3.5   | 3.5   |
| $NM_H$ (V)             | 2.053        | 2.376                                      | 2.198                                      | 1.782  | 1.770  | 1.5018  | 1.4796  |
| $NM_L$ (V)             | 2.067        | 1.751                                      | 1.923                                      | 1.794  | 1.781  | 1.5101  | 1.4876  |
| $t_{pHL}$ (psec)       | 211.3        | 120.7                                      | 117.4                                      | 152.0  | 149.5  | 204.4   | 204.1   |
| $t_{pLH}$ (psec)       | 195.8        | 195.8                                      | 139.9                                      | 145.4  | 143.3  | 202.6   | 202.9   |
| $t_p$ (psec)           | 203.5        | 158.3                                      | 128.6                                      | 148.7  | 146.4  | 203.5   | 203.5   |
| Power (mW)             | 3.93         | 5.06                                       | 6.22                                       | 3.93   | 3.93   | 1.95  | 1.89  |
| % Speed Increase       | -            | 28.6%                                      | 58.3%                                      | 36.9%  | 39.0%  | -   | -   |
| % Power Reduction      | -            | -  | -  | -  | -  | 50.4%   | 52.0%   |

Fig. 8



|                              | Bulk Silicon | Strained-Si on 20% SiGe: High Speed | Strained-Si on 30% SiGe: High Speed | Strained-Si on 20% SiGe: Low Power | Strained-Si on 30% SiGe: Low Power |
|------------------------------|--------------|-------------------------------------|-------------------------------------|------------------------------------|------------------------------------|
| n enhancement                | 1            | 1.75                                | 1.8                                 | 1.75                               | 1.8                                |
| p enhancement                | 1            | 1                                   | 1.4                                 | 1                                  | 1.4                                |
| $W_p$ ( $\mu\text{m}$ )      | 3.11         | 4.12                                | 3.53                                | 4.12                               | 3.53                               |
| $W_n$ ( $\mu\text{m}$ )      | 1.8          | 1.8                                 | 1.8                                 | 1.8                                | 1.8                                |
| $L_n, L_p$ ( $\mu\text{m}$ ) | 1.2          | 1.2                                 | 1.2                                 | 1.2                                | 1.2                                |
| $C_L$ (fF)                   | 22.5         | 26.7                                | 24.2                                | 26.7                               | 24.2                               |
| $V_{DD}$ (V)                 | 5            | 4.5                                 | 4.3                                 | 4.4                                | 3.8                                |
| $NM_H$ (V)                   | 2.370        | 2.275                               | 2.123                               | 2.220                              | 1.872                              |
| $NM_L$ (V)                   | 1.756        | 1.485                               | 1.511                               | 1.458                              | 1.371                              |
| $t_{pHL}$ (psec)             | 148.4        | 117.3                               | 109.3                               | 121.5                              | 132.4                              |
| $t_{pLH}$ (psec)             | 238.5        | 254.8                               | 204.9                               | 265.3                              | 254.4                              |
| $t_p$ (psec)                 | 193.4        | 186.0                               | 157.1                               | 193.4                              | 193.4                              |
| Power (mW)                   | 2.90         | 2.90                                | 2.90                                | 2.66                               | 1.83                               |
| % Speed Increase             | -            | 4.0%                                | 23.1%                               | -                                  | -                                  |
| % Power Reduction            | -            | -                                   | -                                   | 8.4%                               | 37.1%                              |

Fig. 9

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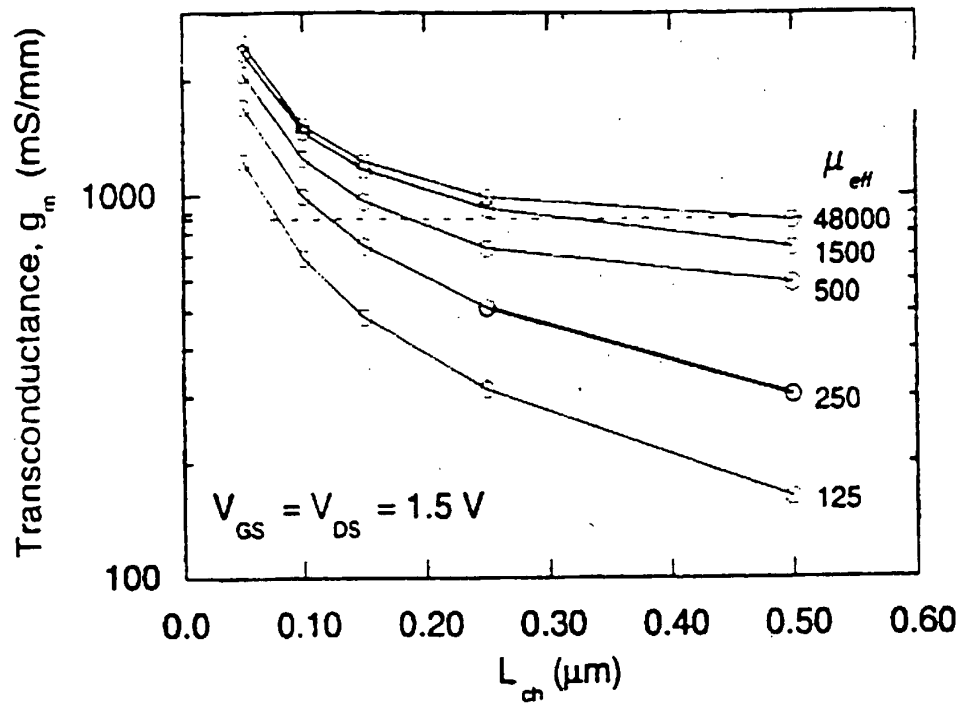


Fig. 10

$\epsilon$ -Si Effect on  $t_p$  for 0.25 $\mu$ m Inverter

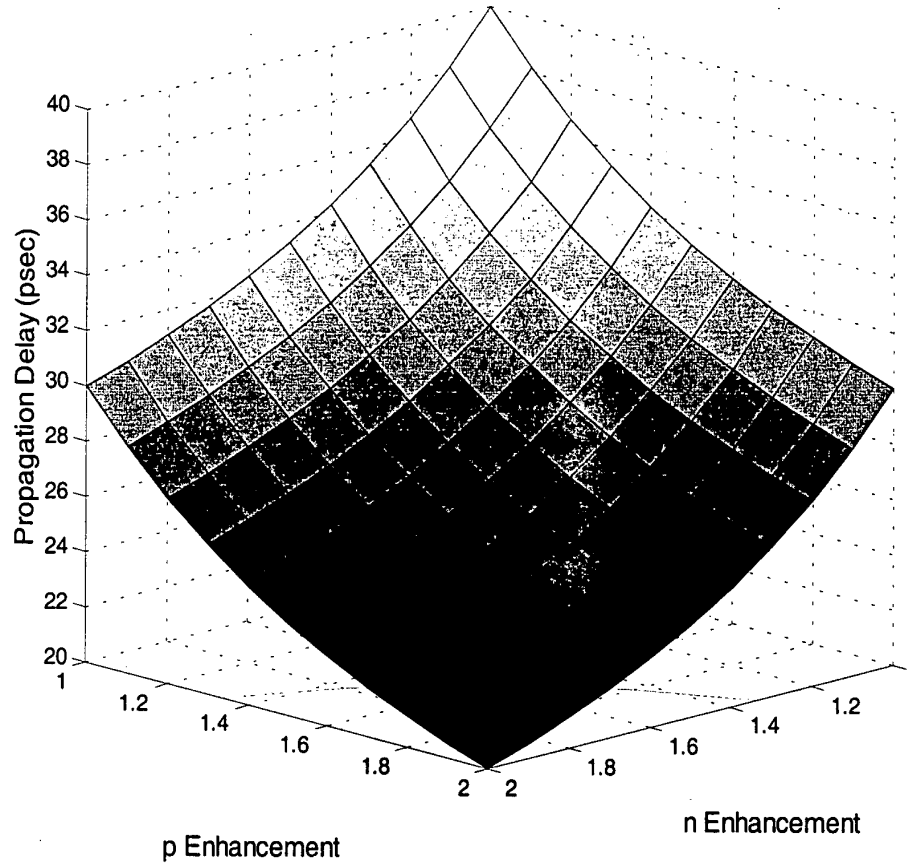


Fig. 11

Fig. 12A

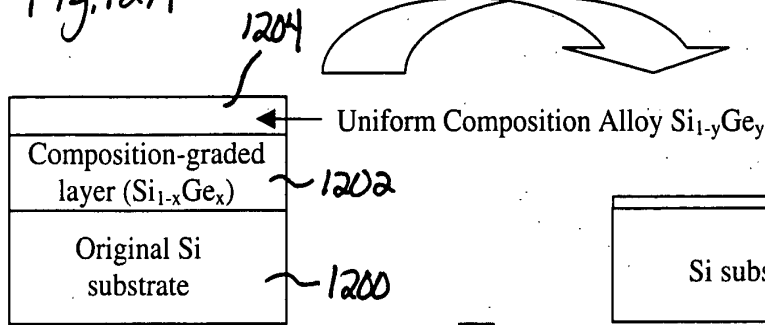


Fig. 12B

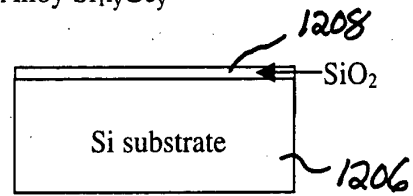


Fig. 12C

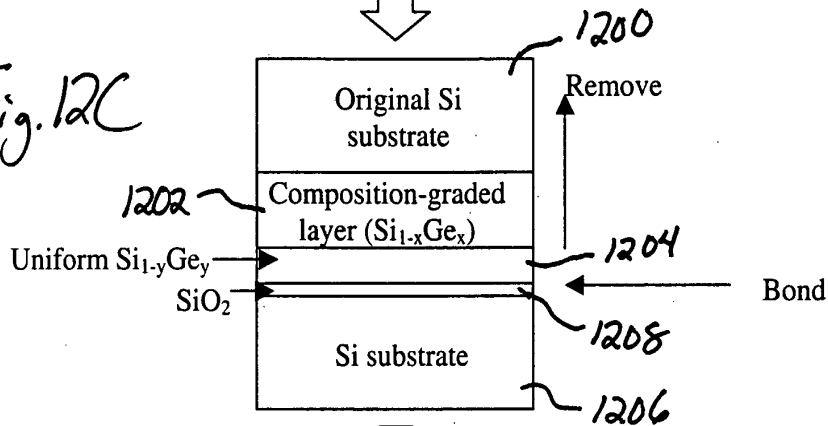


Fig. 12D

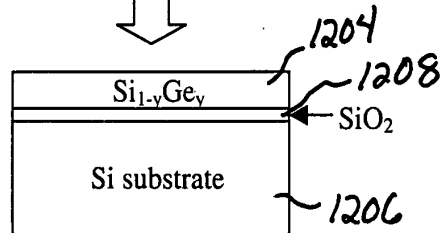
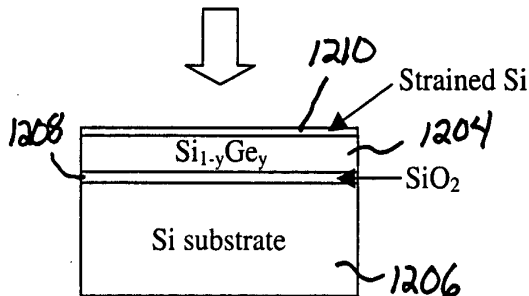


Fig. 12E



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Fig. 13A

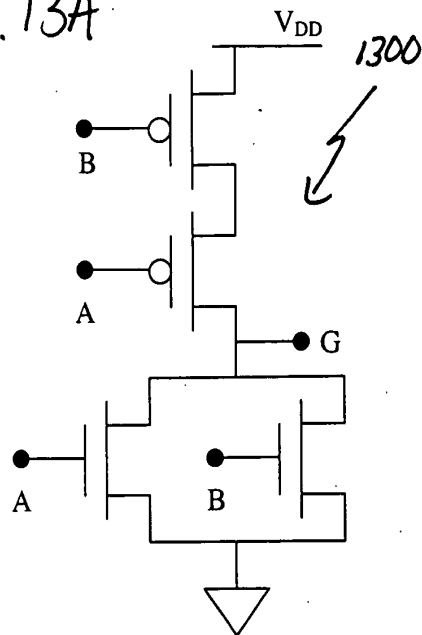


Fig. 13B

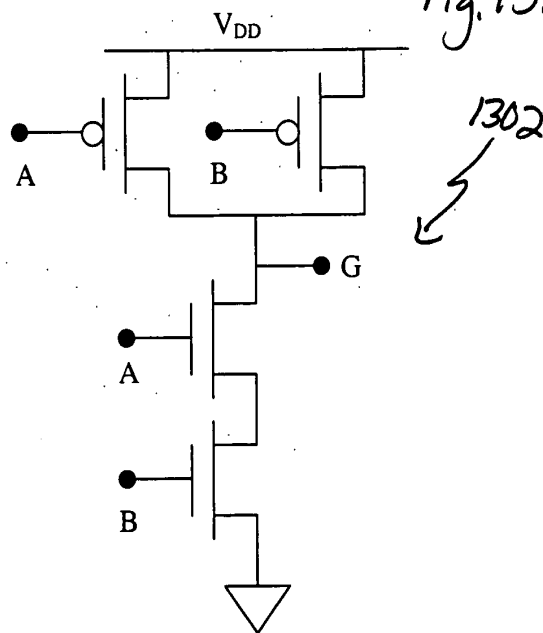


Fig. 13C

